Mayor Bratina and Board of Health Committee Members:

I am aware that the BOH Committee will receive a report on water fluoridation at the April 16th, BOH meeting. Please accept my comments on this practice.

As a member of the Hamilton community and the Green Party of Canada, I have advocated for clean water and other environmental issues, I wish to express my concern regarding the continued use of inorganic fluorides as a Public Health policy.

Adding toxic inorganic fluorides to our drinking water and downstream environment is not a sustainable practice.

In some areas of the Great Lakes, the Canadian Water Quality Guideline (CWQG) for inorganic fluorides, designed to preserve healthy aquatic environments, is being exceeded and it does not make sense to continue adding more of these chemicals. For this reason and others, the Green Party of Canada passed a motion calling for a ban on artificial fluoridation products
http://www.greenparty.ca/motion/g10-p19

Attached, are relevant Canadian Water Quality Guideline documents for Inorganic Fluorides and a Time Line of Canadian/US water quality agreements and laws, which demonstrate that the addition of these toxic substances is in direct violation of these agreements to eliminate these persistent toxic substances from the Great Lakes.

I have recently taken the position of Co-chair for the Great Lakes Water Campaign with the Hamilton Chapter of the Council of Canadians.

I strongly urge the Board of Health Committee to obey Federal and Provincial laws to protect fresh water and end this abuse of our most precious resource.

Regards

Peter Ormond, tel: 905-526-6458

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GreenPartyHamilton.ca *"A vote is cast with each choice made."*

Guidelines at a Glance

July 2002

Canadian Water Quality Guideline

Inorganic Fluorides

This fact sheet describes the Canadian water quality guideline for inorganic fluorides to protect freshwater life. It is part of the series *Guidelines at a Glance*, which summarizes information for the Canadian public on toxic substances and other parameters for which there are Canadian Environmental Quality Guidelines.

The National Guidelines and Standards Office of Environment Canada coordinates the development of Canadian Environmental Quality Guidelines in cooperation with the Canadian Council of Ministers of the Environment (CCME).

Where do inorganic fluorides come from?

The Earth's crust contains about one tenth of a percent of fluorine, making fluorine its thirteenth most common element. Fluorine is widely found in minerals and sedimentary rocks formed by compaction of particles in lakes and oceans. The main fluorine-containing minerals are calcium fluoride, fluoroapatite and cryolite. All compounds that contain fluorine are called fluorides; inorganic fluorides are a subset, referring to those that do not contain carbon. Inorganic fluorides are released slowly from rocks and minerals as they erode under normal weather conditions. Other natural sources for inorganic fluorides are active volcanoes and marine aerosols. Human activities such as mining, phosphate fertilizer production, and aluminium smelting cause unnaturally high levels of inorganic fluorides to be released into air, onto land, or into water.

What happens to inorganic fluorides released into the environment?

When released to air, gaseous inorganic fluorides may combine with water vapour and fall back to Earth in rain while particulate inorganic fluorides attach to fine particles in the atmosphere which eventually settle to the Earth's surface. Most of the naturally occurring inorganic fluorides on land are tightly bound to the soil. When the level of inorganic fluorides exceed that which the soil can retain, inorganic fluorides may be taken up by plants or leached into groundwater. Inorganic fluorides may also be released to water directly (e.g., municipal wastewater discharges). Once in water, inorganic fluorides can be taken up by aquatic plants. Fish and other aquatic animals can also take up inorganic fluoride from water and food and accumulate it in their bones or exoskeletons. Although inorganic fluorides may move around in the environment, and even change form depending on, for example, water chemistry, fluorine itself can not be degraded. Over time, anthropogenic releases of inorganic fluorides may, therefore, cause levels to rise above natural background.

What effects can inorganic fluorides have on our fish and other forms of aquatic life?

Inorganic fluorides affect basic physiological and biochemical processes of fish, plants and other aquatic organisms. By doing so, inorganic fluorides can slow growth and development, cause abnormal behaviour, and lead to death. The degree to which these effects occur depends in part on the concentration and form of inorganic fluoride, period of exposure, water chemistry, and species and age of aquatic species. Some species that seem particularly sensitive include rainbow trout, fingernail clams, water fleas, and certain green algae.

What levels of inorganic fluorides are safe for plants and animals that live in Canadian waters?

The Canadian Water Quality Guideline (CWQG) to protect freshwater life is 0.12 milligrams of inorganic fluoride per litre of water. The guideline is based on a number of scientific studies that examined the impacts inorganic fluorides have on the plants and animals that live in our lakes and rivers. If the level of inorganic fluorides measured in a lake or river is less than the guideline, one would not expect to see adverse health effects in even the most sensitive species. In places where the CWQG for inorganic fluorides is exceeded, an adverse effect on the environment may not necessarily occur. Rather, there is an increased chance of an effect depending on how high above the guideline the levels are, on which kinds of plants and animals live there, and on other characteristics of the water (e.g., how hard the water is). Further investigation at a particular site would be needed to actually determine whether or not there is a negative impact.

How do levels of inorganic fluorides in Canadian lakes and rivers compare to the guidelines?

On average, the level of inorganic fluorides in fresh waters across Canada is 0.05 milligrams of inorganic fluoride per litre of water, or about half of the guideline value. Levels vary from lake to lake and depend, in part, on the presence of minerals containing inorganic fluorides in the immediate and surrounding area, water hardness and pH, and presence of bentonite clays and humic acid.

How can CWQGs be used to make a difference?

In general, Canadian Water Quality Guidelines can be used by Canadian federal, provincial and territorial governments on a voluntary basis to set local guidelines, discharge limits for industry, and remediation (clean-up) targets. CWQGs are most commonly used in environmental assessments as benchmarks or yardsticks to which measured levels are compared. In the case of inorganic fluorides, the guideline could be used by municipalities or industry to ensure that the local levels remain safe for aquatic life. The guideline is of particular relevance to waters that receive direct inputs of inorganic fluorides, for example, from municipalities that fluoridate their water supplies, from aluminium or fertilizer industries, or from areas of heavy fertilizer use. The guideline can be used by anybody to help evaluate if the inorganic fluoride level measured in a sample of water has the potential to cause adverse environmental effects.

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Canadian Water Quality Guidelines for the Protection of Aquatic Life

INORGANIC FLUORIDES

Fluorine (CAS No. 7782-41-4, atomic mass 18.998) is a ubiquitous element of the lithosphere. It belongs to group VII of the periodic table of elements and exists under standard conditions as a pale yellow-green pungent, acrid gas.

The most important natural source of inorganic fluoride in the environment is bedrock from which inorganic fluoride-containing minerals are leached by groundwater and thence into surface water and seawater. In nature, hydrogen fluoride (HF) (molecular weight 20.01 $g{\cdot}mol^{-1}$, density 0.991 $g{\cdot}L^{-1}$) is the most reactive form of fluorine. Other inorganic fluorides of environmental importance include calcium fluoride (CaF_2) (fluorite or fluorspar; molecular weight 78.08 $g{\cdot}mol^{-1}$), sodium fluoride (NaF) (molecular weight 41.99 $g{\cdot}mol^{-1}$), and sulfur hexafluoride (SF_6) (molecular weight 146.05 $g{\cdot}mol^{-1}$).

These four inorganic fluorides have varied uses in Canada. Hydrogen fluoride is used in the production of synthetic cryolite, aluminium fluoride, motor gasoline alkylates, and chlorofluorocarbons (CFCs) (CIS 1996). Calcium fluoride is used as a flux in steel, glass, and enamel production, as the raw material for the production of hydrofluoric acid and anhydrous hydrogen fluoride (Neumüller 1981), and as a molten electrolyte for the separation of oxygen and alumina (Al_2O_3) in aluminium production. Sodium fluoride is used in drinking water fluoridation, as a preservative in glues, in glass and enamel production, and as a flux in steel and aluminium production (Neumüller 1981). Sodium fluoride is also registered for use as a wood preservative in Canada. Sulfur hexafluoride is extensively used as an insulation and current interruption medium in electrical switch gear such as power circuit breakers, compressed gas transmission lines, and various components in substations (James 1992; Environment Canada 1993).

The total estimated annual release of inorganic fluorides from anthropogenic sources to the Canadian environment is in excess of 12 400 $t{\cdot}a^{-1}$. Releases of inorganic fluorides in effluents account for at least 5 500 t (44.7%), whereas over 5 200 t (42%) are emitted in atmospheric outputs (predominantly as HF). Releases of inorganic fluorides to land are estimated to exceed 1 650 t (13.3%). The known major sources of inorganic fluoride releases to the environment include aluminium smelting and phosphate fertilizer production. Collectively, these two major sources account for over 8 700 t (70%) of total inorganic fluorides released (Government of Canada 1993; P. Paine 2000, Environment Canada, pers.com.).

Environmental concentrations in freshwater vary depending on the hydrogeological characteristics. The weathering of alkalic and silicic igneous and sedimentary rocks (e.g., shales) contributes much of the fluoride to natural waters (Warrington 1990). The mean inorganic fluoride level in freshwater across Canada is 0.05 $mg\,F^-{\cdot}L^{-1}$ (0.01–11.0 $mg\,F^-{\cdot}L^{-1}$, n = 51 299) (GSC 1991; Parker 1992). Inorganic fluoride levels in the Great Lakes range from 0.05 to 0.14 $mg\,F^-{\cdot}L^{-1}$ (Warrington 1990). Seawater shows higher fluoride concentrations than freshwater, with a mean inorganic fluoride concentration of 1.3 $mg\,F^-{\cdot}L^{-1}$ (Dobbs 1974). Levels of inorganic fluoride in groundwater vary considerably depending on the hydrogeological characteristics of the underlying bedrock. In Canada, concentrations of fluorides in groundwater vary from 0.02 to 1.2 $mg\,F^-{\cdot}L^{-1}$ and may reach levels as high as 15 $mg\,F^-{\cdot}L^{-1}$ (Lalonde 1976; Warrington 1990; Boyle and Chagnon 1995).

In water, inorganic fluorides remain dissolved in solution under acidic conditions, low hardness, and the presence of ion-exchange material (e.g., bentonite clays and humic acid) and calcium or aluminium ions (Coker and Shilts 1979; Pickering et al. 1988; Sahu and Karim 1989). Fluoride is important for mobilizing aluminium into soluble complexes and, in acidic waters (pH 2–5), fluoride is almost entirely complexed with aluminium (Skjelkvåle 1994; Radic and Bralic 1995).

Inorganic fluoride taken up by aquatic plants is accumulated in cells and cell walls causing chlorosis,

Table 1. Water quality guidelines for inorganic fluorides for the protection of aquatic life (Environment Canada 2001).

Aquatic life	Guideline value ($mg{\cdot}L^{-1}$)
Freshwater	0.12*
Marine	NRG†

*Interim guideline.
†No recommended guideline.

peripheral necrosis, and leaf distortion and malformation (WHO 1984). Animals take up inorganic fluorides from food and drinking water. Approximately 99% of the body burden of fluoride is accumulated in bones and teeth, substituting the hydroxyl groups in the bone apatite [$Ca_5(OH,F)(PO_4)_3$] (WHO 1997). Fluoride can also be accumulated in soft tissue (Neuhold and Sigler 1960; Wright and Davison 1975; Wright 1977). The accumulation of inorganic fluorides in aquatic biota is primarily determined by the route of exposure, levels of bioavailable inorganic fluorides, and uptake/excretion kinetics. There is no evidence that inorganic fluorides bioaccumulate through aquatic food chains; however, inorganic fluorides have been found to accumulate to potentially toxic levels in dairy cows fed bonemeal as a food supplement.

Water Quality Guideline Derivation

The interim Canadian water quality guideline for inorganic fluorides for the protection of freshwater life was developed based on the CCME protocol (CCME 1991). Due to insufficient data, no guideline for inorganic fluorides in marine waters could be derived (Environment Canada 2001).

Freshwater Life

Studies for freshwater fish focused predominantly on survival of rainbow trout *(Oncorhynchus mykiss)* and brown trout *(Salmo trutta)*. For acute studies (72–192 h), LC_{50}s ranged from 20 to 223 mg $F^{-}\cdot L^{-1}$ for these species (Wright 1977; Camargo 1991). In longer term studies (10–21 d), LC_{50}s ranged from 2.3–7.3 to 75–91 mg $F^{-}\cdot L^{-1}$ for juvenile rainbow trout and brown trout fry, respectively (Angelovic et al. 1961; Neuhold and Sigler 1960). Pimentel and Bulkley (1983) recorded a 96–h LC_{50} of 51.0 mg $F^{-}\cdot L^{-1}$ at 17 mg $CaCO_3\cdot L^{-1}$ for rainbow trout averaging 58 mm in length. These authors demonstrated a linear relationship between water toxicity and hardness.

Field and laboratory studies demonstrating the sublethal effects of fluorides are available also. Migration patterns of chinook *(O. tschawytscha)*, chum *(O. keta)*, and coho *(O. kisutch)* salmon were disrupted when fish were exposed to fluoride levels of 0.5 mg $F^{-}\cdot L^{-1}$ prior to and during migration runs. For these species, the authors suggest a threshold for fluoride sensitivity of 0.2 mg $F^{-}\cdot L^{-1}$ (Damkaer and Dey 1989). In the field part of this study, aluminium levels in the river may have been a confounding factor.

With regard to invertebrates, neonates of *Daphnia magna* experienced impaired reproduction and reduced hatchability at fluoride levels of 34 mg $F^{-}\cdot L^{-1}$ beginning on day 12 of a 21-d exposure test (Fieser et al. 1986). In contrast, Dave (1984) estimated the 21-d NOEL for growth and reproduction in *D. magna* to be an order of magnitude lower, between 3.7 and 7.4 mg $F^{-}\cdot L^{-1}$ in reconstituted hard water (250 mg $CaCO_3\cdot L^{-1}$); however, there was no clear dose–response relationship in this study. Sanders and Cope (1966) investigated survival of *D. pulex* and *Simocephalus serrulatus*. The 48-h EC_{50}s for immobilization of *D. pulex* and *S. serrulatus* were 2.71 and 5.43 mg $F^{-}\cdot L^{-1}$, respectively. Cryolite (Na_3AlF_6) was used as a test substance, therefore, aluminium-based toxicity could be a confounding factor to these results. The exposure of fingernail clams *(Musculium transversum)* to 2.8 mg $F^{-}\cdot L^{-1}$ during an 8-week bioassay led to 60% mortality compared to 25% among control clams (Sparks et al. 1983).

A series of acute static tests on eight species of net-spinning caddisflies was conducted by Camargo (1996), Camargo et al. (1992), and Camargo and Tarazona (1991) among others. *Hydropsyche bronta* was the most sensitive species with 48-, 96-, and 144-h LC_{50} values of 52.6, 17.0, and 11.5 mg $F^{-}\cdot L^{-1}$, respectively (Camargo et al. 1992). Camargo (1996) re-evaluated some of these data and reported a slightly lower 96-h LC_{50} of 15.8 mg $F^{-}\cdot L^{-1}$. Sublethal effects were also tested in five of the eight species. The 96-h EC_{50}s for net larvae migration ranged from 22.95 mg $F^{-}\cdot L^{-1}$ for *H. bulbifera* to 43.09 mg $F^{-}\cdot L^{-1}$ for *H. lobata*; *H. bronta* was not tested (Camargo and Tarazona 1990; Camargo and La Point 1995). Water quality conditions were similar among tests (e.g., water hardness varied from 12 to 40 mg $CaCO_3\cdot L^{-1}$).

Most plant species were not as sensitive as fish and invertebrate species, with one exception. The green alga *Chlorella pyrendoidosa* showed a growth inhibition of 37% after 48 h exposure to fluoride levels as low as 2.0 mg $F^{-}\cdot L^{-1}$ (Smith and Woodson 1965).

The interim guideline for total inorganic fluorides is 0.12 mg $F^{-}\cdot L^{-1}$. This guideline is derived from the lowest acceptable adverse effect level reported: a 144-h LC_{50} value of 11.5 mg $F^{-}\cdot L^{-1}$ for the caddisfly *Hydropsyche bronta* (Camargo et al. 1992; Camargo 1996). Sodium fluoride was used as the fluoride-containing compound. Duplicate tests were conducted with a control and five different fluoride concentrations. Throughout the experiment, fluoride concentrations and physicochemical parameters were measured. The water quality conditions (temperature of 18°C; pH 7.8, 9.5 mg$\cdot L^{-1}$ for dissolved oxygen; water hardness of 40.2 mg $CaCO_3 \cdot L^{-1}$) are suitable for *H. bronta* and applicable to Canadian freshwaters. Moreover, *Hydropsyche bronta* is a caddisfly species found in Canada. As the LOEL of 11.5 mg $F^- \cdot L^{-1}$ value is an acute, lethal endpoint, a safety factor of 0.01 was applied.

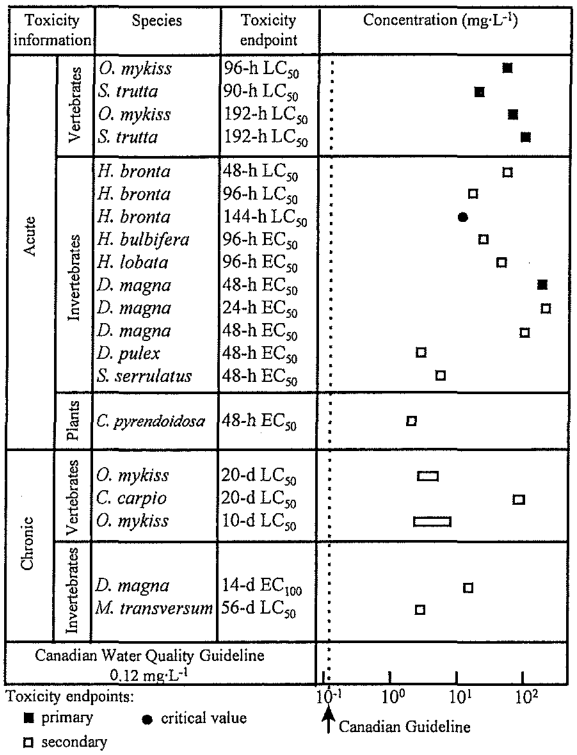

Figure 1. Select freshwater toxicity data for inorganic fluorides.

Several studies have shown that inorganic fluoride toxicity is negatively correlated with water hardness and positively correlated with ambient temperature (Angelovic et al. 1961; Pimentel and Bulkley 1983; Smith et al. 1985; Fieser et al. 1986); however, there currently are insufficient data to develop a quantitative correlation or a guideline matrix. Further multifunctional experiments at various combinations in the parameters (i.e., water hardness and temperature) are needed to derive Canadian water quality guidelines that are based on these parameters. Nevertheless, it is expected that factors such as water hardness and temperature, the presence of cations such as calcium, magnesium (Pimentel and Bulkley 1983; Smith et al. 1985), and, potentially, selenium (Pang et al 1996) or anions such as chloride (Neuhold and Sigler 1962) can reduce the toxicity of inorganic fluorides on a site-specific basis.

In contrast, fluoride toxicity to aquatic plants (Husaini et al. 1996; Rai et al. 1998) and, potentially, aquatic animals is enhanced by the presence of metals, especially aluminium. In water, inorganic fluorides remain dissolved in solution under acidic conditions, low hardness, and the presence of ion-exchange material (e.g., bentonite clays and humic acid) and of calcium or aluminium ions (Coker and Shilts 1979; Pickering et al. 1988; Sahu and Karim 1989). Fluoride is important for mobilizing aluminium into soluble complexes. At pH 5 and below, fluoride is almost entirely complexed with aluminium (Skjelkvåle 1994; Radic and Bralic 1995). Therefore, judiciousness is required when using guidelines at a specific site. For more information on the toxicity of aluminium, see also the Canadian water quality guideline for the protection of aquatic life for aluminium.

Lastly, migratory anadromous fish should be considered in the development of site-specific objectives, where appropriate. Anadromous fish species appear to be more sensitive to inorganic fluorides in freshwater (effects observed at levels as low as 0.5 mg $F^- \cdot L^{-1}$) than in marine water where the natural concentration inorganic fluoride averages 1.3 mg $F^- \cdot L^{-1}$ (Damkaer and Dey 1989; Dobbs 1974).

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Excerpt from Publication No. 1299; ISBN 1-896997-34-1

Aussi disponible en français.

Time Line: Hydrofluorosilicic acid is an Inorganic Fluoride - Toxic Substance & Hazardous Waste

People for Safe Drinking Water

"Water fluoridation is not a public health policy. It is a hazardous waste management policy." Dr. J. William Hirzy, Senior US EPA Chemist, VP US EPA Headquarters Union

US EPA Unions representing over 7,000 professionals write to US Congress asking for a national moratorium on artificial fluoridation of drinking water.
http://www.nteu280.org/Issues/Fluoride/Press%20Release.%20Fluoride.htm

1909 Boundary Waters Treaty http://www.ijc.org/rel/agree/water.html#what

- **Article IV:** "It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

1972 Great Lakes Water Quality Agreement

- **Article II:** 'The purpose of the Parties is to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem.'
- "These waters should be: Free from substances entering the waters as a result of human activity in concentrations that are toxic or harmful to human, animal or aquatic life."

1978 Great Lakes Water Quality Agreement http://www.ijc.org/rel/agree/quality.html

- 'the discharge of any or all persistent toxic substances be virtually eliminated.'

1989 First Priority Substances Lists www.ec.gc.ca/substances/ese/eng/psap/psl1-1.cfm

- Priority Substances List 1 - 44 substances/groups of toxic substances include inorganic fluoride (hydrofluorosilicic acid), arsenic, lead, mercury & radionuclides

1997 Binational Toxics Strategy http://www.ijc.org/php/publications/html/bts/btse.html#lot

- "...will work in cooperation with their public and private partners toward the goal of **virtual elimination** of persistent toxic substances resulting from human activity, particularly those which bioaccumulate, from the Great Lakes Basin

CEPA 1999, 2006 update of Toxic Substances
http://www.ec.gc.ca/CEPARegistry/subs_list/Toxicupdate.cfm

- "**Virtual elimination** of the most dangerous toxic substances is at the core of Canada's Toxic Substances Management Policy"

CEPA 1999, Section 65 (3) Toxic Substances Definition

- "substances determined to be **"toxic", persistent, bioaccumulative, anthropogenic**, and which are not naturally occurring radionuclides or naturally occurring inorganic substances shall be proposed for implementation of virtual elimination under Section 65 (3) of CEPA 1999." http://www.ec.gc.ca/CEPARegistry/subs_list/ToxicList.cfm

CEPA 1999, Section 64 Risk Assessment of Schedule 1 Substances

"A substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that: http://www.ec.gc.ca/ceparegistry/subs_list/Toxic.cfm

1. have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
2. constitute or may constitute a danger to the environment on which life depends; or
3. constitute or may constitute a danger in Canada to human life or health."

2002 Safe Drinking Water Act http://www.ene.gov.on.ca/envision/water/sdwa/index.htm

Section 20 (1): No person shall cause or permit any thing to enter a drinking-water system if it could result in (a) a drinking-water health hazard;

Section 20 (3): Dilution no defence

- For the purposes of prosecuting the offence of contravening subsection (1), it is not necessary to prove that the thing, if it was diluted when or after it entered the system, continued to result in or could have resulted in a drinking-water health hazard.

2006 Clean Water Act http://www.ene.gov.on.ca/en/water/cleanwater/index.php

Section 15(2)(i): Requirement to identify past conditions that threaten source water that: "are or would be drinking water threats"

Relative Toxicity: The toxicity of fluoride is comparable to that of arsenic and lead.
Government policy permits fluoride levels 150 times higher than lead and arsenic.

Maximum Concentration Level of Arsenic = 10ppb
Maximum Concentration Level of Lead = 10ppb
Maximum Concentration Level of Fluoride = 1,500ppb

From: Robert E. Gosselin et al, Clinical Toxicology of Commercial Products 5th ed., 1984